Mémoire sur Quelques Faits relatifs à la Stridulation des Orthoptères et à leur distribution Géographique en Europe. Par M. Yersin, Prof. 8vo pamph. Lausanne.

Giambattista Dattino.

Arringhe Officiose dell' Avocato Giambattista Dattino gia Assessore Demaniale della Provincia di Chieti Socio di diversi Accademie. 8vo vol. Naples. 1863.

Prof. Giovanni Capellini.

Studi Stratigrafici e Paleontologici sull' Infralias nelle Montagne dell Golfo della Spezia, con due Tavole. 4to pamph. Bologna. 1862.

Carta Geologica dei dintorni dell Golfo della Spezia e Val di Magra Inferiore. Bologna. 1863.

Five hundred and fifty-sixth Meeting.

October 10, 1865. — ADJOURNED STATUTE MEETING.

The PRESIDENT in the chair.

The President called the attention of the Academy to the recent decease of Dr. Francis Wayland of Providence, of the Associate Fellows; also among the Foreign Honorary Members, of Sir John William Lubbock, Sir William Rowan Hamilton, the astronomer Encke, Admiral William H. Smyth, and Admiral Lois Isidore Duperrey.

Mr. John C. Lee was elected Treasurer of the Academy to fill the vacancy left by the declination of Mr. Bowditch, who was elected at the previous meeting.

Mr. Ferrel presented the following paper: —

On an Annual Variation in the Daily Mean Level of the Ocean, and its Cause.

IN discussing a large number of tidal observations, made at Brest, one of the results obtained is an annual variation of the mean level of the ocean which cannot be explained by the hitherto recognized changes of mean level. The mean height obtained for each month of the year is given in the following table, in which each monthly mean

is the result of about 800 observations of high water and as many of low water. The only causes which have been supposed to affect the mean level are a small astronomical term depending upon the sun's declination, the variation of atmospheric pressure, and the winds. The effect of the astronomical term is equal to $a \cos 2l$, in which a is a function of the latitude of the port, and l is the sun's longitude. The effect of the variation of atmospheric pressure is equal to $13^m.568\ (P-p)$, in which p is the observed barometric pressure of the atmosphere in meters, and P the annual mean pressure. The coefficient $13^m.568$ is assumed upon the hypothesis that the variation of the mean level of the ocean at any place is to the variation of the barometric column as the specific gravity of mercury is to that of water. M. Dausy obtained $15^m.5$ for this coefficient from 150 observations of the tides and of atmospheric pressure, made at Lorient, but Mr. Lubbock from observations at Liverpool obtained only 11.1 for that port. The theoretical value is perhaps more nearly correct than either of the other two. In the second numerical column of the following table is given the atmospheric pressure at Paris in millimetres for each month of the year, taken from Kaemtz's Meteorology, which is assumed to vary but little from the pressure at Brest, so that it may be used in computing the effect of the variation of pressure upon the mean level of the sea at that port. The following variations of mean level corrected for the astronomical term and variation of atmospheric pressure must be the effect of the winds, and other causes. The value of a in the astronomical term for the latitude of Brest is $-.007$. The corrections and the corrected monthly mean heigths of the ocean are also given in the following table.

Month.	Monthly Mean Heights.	Atmospheric Pressure.	Astronomical Correction.	Atmospheric Correction.	Corrected Mean Heights.
	m.	mm.			
	4.437	756.46			4.437
January	+ 0.020	+ 2.40	— 0.005	+ 0.032	+ 0.047
February	— 0.016	+ 2.63	+ 0.003	+ 0.035	+ 0.022
March	— 0.054	— 0.13	+ 0.007	— 0.002	— 0.049
April	— 0.033	— 1.28	+ 0.005	— 0.017	— 0.045
May	— 0.019	— 0.85	— 0.003	— 0.011	— 0.033
June	— 0.061	+ 0.82	— 0.007	+ 0.011	— 0.057
July	— 0.043	+ 0.06	— 0.005	+ 0.001	— 0.047
August	— 0.030	+ 0.28	+ 0.003	+ 0.004	— 0.023
September	— 0.005	+ 0.15	+ 0.007	+ 0.002	+ 0.004
October	+ 0.076	— 2.04	+ 0.005	— 0.027	+ 0.054
November	+ 0.071	— 0.70	— 0.003	— 0.010	+ 0.058
December	+ 0.073	— 1.37	— 0.007	— 0.018	+ 0.068

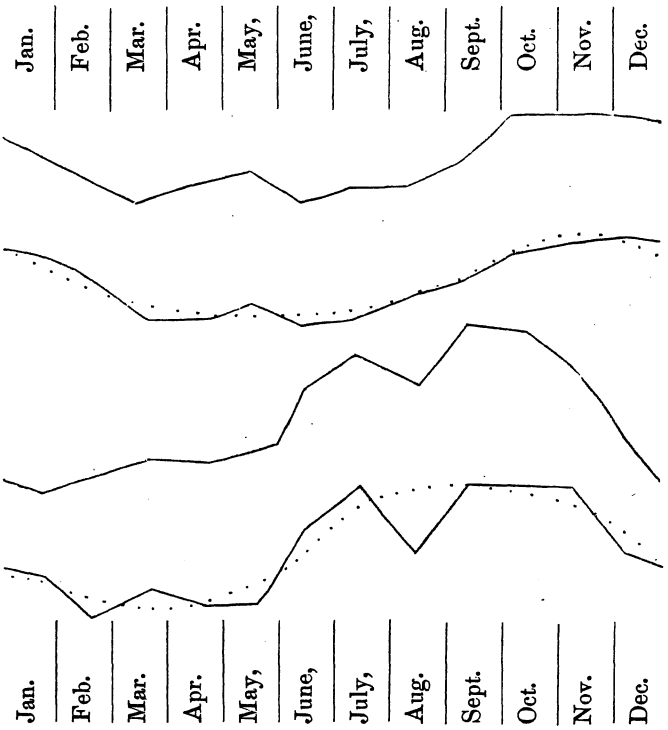
In connection with these results are given in the following table those obtained by Dr. Bache from the discussion of the tides at Key West, Florida, and published in the Coast Survey Reports, and also in Silliman's Journal (Second Series, Vol. XVIII. p. 305). They have been reduced from English feet to meters for convenience of comparison with the preceding results. The second numerical column contains the variations of atmospheric pressure at Havana, which is used for computing the corrections at Key West due to that cause. The coefficient of the astronomical term for Key West is + .005. The corrections and the corrected results are also given in the following table: —

Month.	Monthly Mean Heights.	Atmospheric Pressure.	Astronomical Correction.	Atmospheric Correction.	Corrected Mean Heights.
	m.	mm.			mm.
	1.677	760.27			1.677
January	— 0.118	+ 4.97	+ 0.003	+ 0.066	— 0.049
February	— 0.100	— 0.12	— 0.002	— 0.002	— 0.104
March	— 0.073	+ 0.71	— 0.005	+ 0.009	— 0.069
April	— 0.073	— 0.69	— 0.003	— 0.009	— 0.085
May	— 0.055	— 2.08	+ 0.002	— 0.028	— 0.081
June	+ 0.031	+ 0.40	+ 0.005	+ 0.005	+ 0.041
July	+ 0.085	+ 0.40	+ 0.003	+ 0.005	+ 0.093
August	+ 0.040	— 2.94	— 0.002	— 0.039	— 0.001
September	+ 0.130	— 2.81	— 0.005	— 0.037	+ 0.088
October	+ 0.121	— 2.08	— 0.003	— 0.028	+ 0.090
November	+ 0.070	+ 0.98	+ 0.002	+ 0.013	+ 0.085
December	— 0.058	+ 3.35	+ 0.003	+ 0.045	— 0.008

For the convenience of comparison the following graphic representation of the results for the two ports is given, the first and third curves representing the annual variation of mean level at Brest and Key West respectively, uncorrected for the effects of the astronomical term and the variation of atmospheric pressure, and the second and fourth the corrected results. The curves are somewhat irregular, because the number of both tidal and barometric observations is not great enough to eliminate all the accidental and other irregularities; but the dotted curves, cutting off small irregularities, although somewhat arbitrary, must very nearly represent the true results.

With regard to the effect of the winds in changing the mean level of the sea, either at Brest or Key West, little is known, but it is evident from various researches at other ports, that they can have but little effect, except for very short periods during heavy gales, and therefore cannot cause much change in the monthly means, or the means of the different seasons. M. Dausy concluded from his researches that the mean level of the sea was not sensibly altered at Lorient by breezes

or fresh winds, but that it fell $0^{m}.080$ by violent winds from the north to northeast, and rose the same quantity by those from the southwest, the south, or the southeast. (*Comptes Rendus de l'Académie des Sciences*, Tom. III. p. 136.) We have, therefore, reason to suppose that the variations in the prevailing winds in the different seasons of the year, since their averages or resultants cannot amount to more than a very gentle wind, can have but a small effect upon the mean level at Brest. Moreover, the winds from the south and southwest, which tend to cause a rise in the mean level, prevail the most, and with the greatest force, during the winter and spring, and hence cannot cause the preceding corrected variation of mean level, which is at its minimum during that time. There must, therefore, be yet some other cause affecting the mean level of the sea at Brest.



With regard to the effect of the winds on the mean level of the sea at Key West, Dr. Bache remarks, that "winds tending to elevate the water in the harbor prevail for six months, from March to August

inclusive, and those tending to depress it, for the other six months, from September to February inclusive." By referring to the preceding curve representing the variation of mean level at Key West, it is seen that these winds cannot cause the corrected variation of mean level, since the argument of variation of the former does not at all correspond with that of the latter, and hence there must be still some other cause affecting the mean level of the sea at Key West also.

From what has been stated, it is evident that the effect of the winds at Brest must be to decrease the amount of variation, and to cause the maximum and minimum to happen a little later in the season of the year. On the other hand, their effect at Key West must increase the variation and cause the maximum and minimum to happen earlier in the season of the year. If, therefore, the variations of mean level at Brest and Key West were corrected for the effect of the winds, the arguments of the variations at both ports would probably be the same, making the maxima and minima of the variations about October and April. This indicates that the cause or causes of the variation of mean level which we have yet to seek are not local, but more general, affecting both ports simultaneously. There have been no researches to show that the argument of the corrected variation of mean level would be about the same at other ports of the Atlantic ocean also.

There is still another cause affecting the mean level of the ocean at different seasons, which is much more effective than either of those which have been stated, and which, I think, satisfactorily accounts for the remaining and greater part of the observed variation, which has not been explained. This is a tangential force arising from the motions of the ocean combined with the motion of the earth's rotation. It was first brought out in its most general form in my paper on the "Motions of Fluids and Solids relative to the Earth's Surface," published in the Mathematical Monthly, and also in an abridged form in Silliman's Journal (Second Series, Vol. XXXI.), and expressed in the following language: *In whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern hemisphere.* From this force there must arise a change in the level of the sea wherever its waters have a motion of any kind, and as these motions depend, for the most part, upon the difference of temperature of the ocean between the equator and the poles, and consequently upon the change of seasons, there must be a change in the mean level of the

sea at most ports corresponding with the change of seasons. The principal motion of the water of the Atlantic Ocean affecting its level is the motion by which it is supposed to complete a gyration in about three years. In the paper already referred to it was shown that the force arising from this gyration would cause the middle of the gyrating mass of the water to stand about five feet higher than the exterior part on the coast of Europe and America. Now as the greatest difference of temperature in the ocean between the equator and the poles must be in the latter part of winter, a little later than the time of the greatest difference in the atmosphere between the equator and the poles, the greatest gyratory motion of the water of the Atlantic Ocean, on account of the inertia of the water, must happen still a little later, say in April, and then the surface of the water must stand highest in the centre of the gyrating part, and lowest at the exterior part, and consequently at the ports of Brest and Key West. On the contrary, in October, when the gyratory motion is the least, the surface must fall a little in the middle and rise a little at its exterior part, and consequently stand at its maximum height at the ports of Brest and Key West. The position of the gyrating mass also changes with the seasons, being farthest north in the fall, and nearest the equator in the spring, as must necessarily be the case, and as the vibrating motion of the northern part of the Gulf Stream indicates. The surface of the gyrating water being a little convex, this circumstance must also affect the mean level slightly at some ports.

The difference between the maximum and minimum mean height of the sea at Brest is about six inches, which, when corrected for the effect of the winds and other causes, would probably be a little more. The difference at Key West, corrected in like manner, would probably be about the same. A decrease, therefore, of less than one half in the gyratory velocity of the ocean from April to October would be sufficient to cause a variation of that amount in the mean level of the sea at Brest and Key West; and as the argument of the variation of the gyratory motion of the Atlantic Ocean, as we have seen, must very nearly or quite correspond with the argument of the variation of mean level unaccounted for by other causes, we have reason to think that the variation of the gyratory motion of the Atlantic Ocean is the cause of this part of the change of mean level.